

Opportunities for CISE Researchers in Sustainability

Krishna Kant and Petros Drineas

Directorate of Computer and Information Sciences

National Science Foundation

Oct 14, 2011, 13:00 – 14:45

Welcome by

Dr. Farnam Jahanian

Assistant director
CISE Directorate

Dr. Keith Marzullo

Division Director
Computer & Network Systems (CNS) division

Agenda

13:00 Welcome by CISE Management

13:10 Overview of SEES – Jessica Robin, Krishna Kant

13:25 SEES solicitations

- Sustainable Energy Pathways – Krishna Kant
- SRN and RCN-SEES – Krishna Kant
- SEES Fellows – Petros Drineas
- PIRE-SEES, CNH, WSC – Petros Drineas

14:15 Questions

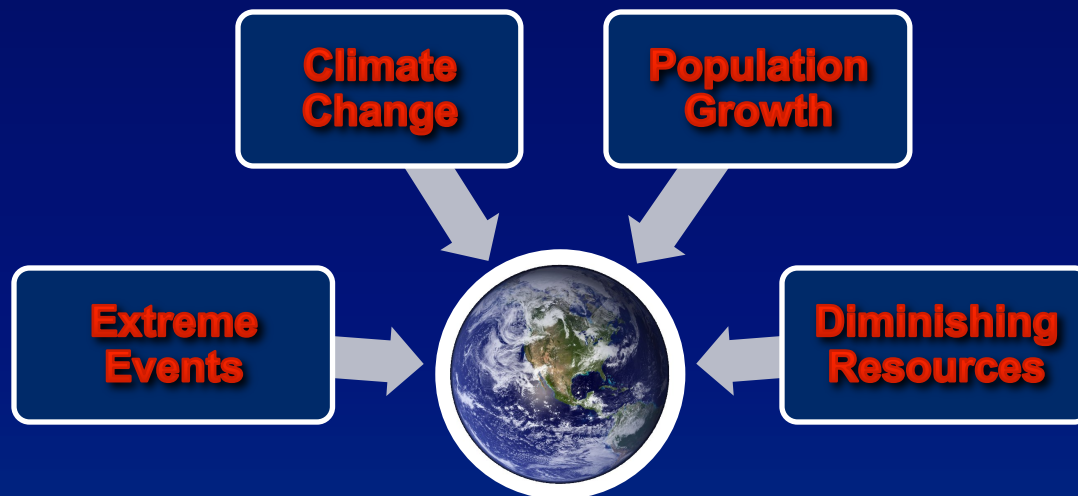
The Sustainability Challenge

Dr. Jessica Robin
Office of International Science and Engineering

A World Under Pressure

There are increasing natural and anthropogenic pressures on our natural and social systems

- 3 major earthquakes in 2010-2011 – Haiti, Chile and Japan
Japan also experiencing tsunami & nuclear crisis simultaneously.
- Unsustainable population growth & its impact
- Diminishing resources such as fresh-water, forest cover, and others



Sustainability Issues Remain at the Forefront

- Sustainability issues remain at the forefront both in academic journals and popular media.
- Sustainability science is emerging as a new academic discipline

Neither “basic” nor “applied” research but as a field defined by the problems it addresses rather than by the disciplines it employs.

-- William Clark in Proc. of National Academy of Sciences

The Challenge of Sustainability

What is Sustainability?

The interactions between natural and social systems, and how those interactions affect the challenge of... meeting the needs of the present and future generations while substantially reducing poverty and conserving the planet's life support systems

It is more than just climate change or energy, or disaster response, or ...



It is research at the nexus of societal needs and behavior, environmental impact, and economic demands

Meeting the Challenge

**Requires
multifaceted
approaches**



**Understanding
change and
projections of
impact**

**Adaptation
methods and
technologies**

**Mitigation
actions and
technologies**

**Human well-
being on a
crowded planet**

Role of Science and Technology

**Inform decision
making to drive
policy**

**Create new products
and capabilities with
deep societal impact**

**Prepare the
workforce to address
global change**

Science, Engineering, and Education for Sustainability (SEES)

To advance science, engineering, and education to inform the societal actions needed for environmental and economic sustainability and sustainable human well-being

Support interdisciplinary research and education that can facilitate the move towards global sustainability

Build linkages among existing projects and partners and add new participants in the sustainability research enterprise

Develop a workforce trained in the interdisciplinary scholarship needed to understand and address the complex issues of sustainability

GOALS

Prior NSF SEES Activities

NSF sponsors 5 climate focused solicitations in FY10

- Earth Systems Modeling (EaSM)
 - \$50-\$35M total awards including DoE & USDA
- Ocean Acidification (OA)
- Dimensions of Biodiversity (DB)
- Water, Sustainability, and Climate (WSC)
- Climate Change Education (CCEP)

NSF issues Dear Colleague Letter

- Issued on January 2011 (NSF 11-022)
- Informs community on the planned future of SEES activities

NSF continues to support SEES efforts through FY11

- Research coordination networks (RCN)
- Couple natural human systems (CNH) solicitation
- Planning workshops, fostering international collaboration, and more



Fiscal Year 2012 Priorities

- Advance a clean energy future
- Nurture the emerging SEES workforce
- Expand research, education, and knowledge dissemination
- Develop interdisciplinary research networks
- Engage with global partners

Tremendous opportunity to build on NSF strengths and efforts



Role of CISE in SEES

Monitoring

- **Scalable sensing & data collection for sustainability apps**
 - Ocean ice dynamics
 - Biodiversity tracking,
 - Water quality & availability
 - Disaster monitoring
 - Human well being (e.g., healthcare for masses)
- **Sensing in difficult environments (e.g., arctic, wild-fires, animals)**
- **Working with citizen science data**

Big Data

- **Involves processing massive data:**
 - Integrating multimodal data
 - Dealing with missing/unreliable data
 - Storage and dissemination
 - Management, visualization and understanding

Foundations

- **Addressing complexity**
 - Problem abstractions
 - Multi-level modeling
 - Symbolic/numeric modeling
 - Reasoning in uncertain environments
 - Crowdsourcing
 - Autonomous Control
- **Addressing scale**
 - Algorithms in the field
 - New architectures
 - Multicore & cloud computing
 - Software engineering



Workshops Exploring Sustainability

- US-China workshop on CS & Sustainability Challenge
 - DIMACS, Rutgers University, Sept 2011
 - <http://dimacs.rutgers.edu/Workshops/China4/program.html>
- Workshop on info. & comm. technologies for sustainability
 - SECON, Salt-lake City, June 2011
 - <http://www.cs.ucdavis.edu/~liu/WICS/SustainabilityReport.pdf>
- Role of Info., Sci. & Eng. In Sustainability
 - CCC workshop, Washington DC, Feb 2011
 - http://cra.org/ccc/seesit_report.php
- Science of sustainability workshop
 - Warrenton, VA, Nov 2009
 - www.nsf.gov/mps/dms/documents/SustainabilityWorkshopReport.pdf



CISE Centric Sustainability Programs

Core

- Energy efficient IT design and energy management
- Sensor networks and embedded computing for sustainability applications
- Increasing interest in broader sustainability aspects of computing

Cross Cutting

- Programs include Cyber Physical Systems (CPS) and Smart Health and Wellbeing (SHW)
- Includes projects in smart homes/buildings, smart grid, vehicles, healthcare, and more

Large Scale

- CISE Expedition awards funds up to \$2M a year for up to 5 years
- Awards include projects on Computational Sustainability (Cornell) and Data Driven Climate Modeling (University of Minnesota)



Current SEES Portfolio

CISE Sponsored 2012

SEP

Sustainable Energy Pathways

SRN SEES

Sustainability Research Networks

RCN SEES

Research Coordination Networks

PIRE SEES

Partnerships for Int. Rsrch & Edu

SEES Fellows

Preparing New Researchers

Others 2012

WSC

Water Sustainability and Climate

CNH

Coupled Natural Human Systems

OA

Ocean Acidification

Past – not available

EASM

Modeling Earth Systems

DBD

Dimensions of Biodiversity

CCE

Climate Change Education

Common SEES Solicitation Requirements

Must be interdisciplinary by design

- Proposals fundable by core program of directorates not suitable.
- Integration of multi-disciplinary parts is important

Must promote interdisciplinary education & training

- Integrating multi-disciplinary education into core curriculum
- Enhancing cross disciplinary interaction
- Creation of infrastructure for multidisciplinary research
- Enhancing public's understanding of sustainable energy future

Must go beyond just creating technologies – need to consider social, economic, and environmental aspects

- Proposals requires only consideration, not in-depth treatment.
- Depth of treatment depends on proposal scope



FY12 Solicitations

1. SEP
2. RCN-SEES
3. SRN
4. Fellows
5. PIRE
6. WSC/CNH



Sustainable Energy Pathways

NSF 11-590

Amount

\$34M for 15 -20 awards

Awards

Up to \$500K/year

Up to 4 years

Requirements

At least 3 PIs (one lead, 2 co-PIs)

Represents 2 or more disciplines

Restrictions

Max 3 proposals per organization

Max 1 proposal per PI

To develop efficient pathways towards sustainable energy, from starting points to ending points, via a systems approach in the priority areas of

- Sustainable Energy Harvesting, Conversion, and Storage
 - Energy harvesting and conversion
 - Energy storage solutions
 - Critical elements and materials
 - Nature inspired processes
 - Reducing carbon intensity
- Energy Transmission, Distribution, Efficiency, and Use
 - Transmission and distribution
 - Energy efficiency and management

Due Date, Feb 01, 2012



SEP Requirements and Review Criteria

The extent to which the proposal articulates SEP vision

- Embraces the overarching theme of sustainability,
- Develops and integrates scientific knowledge & technological innovation, with environmental, societal, & economic aspects.

Synergistic engagement of multiple disciplines

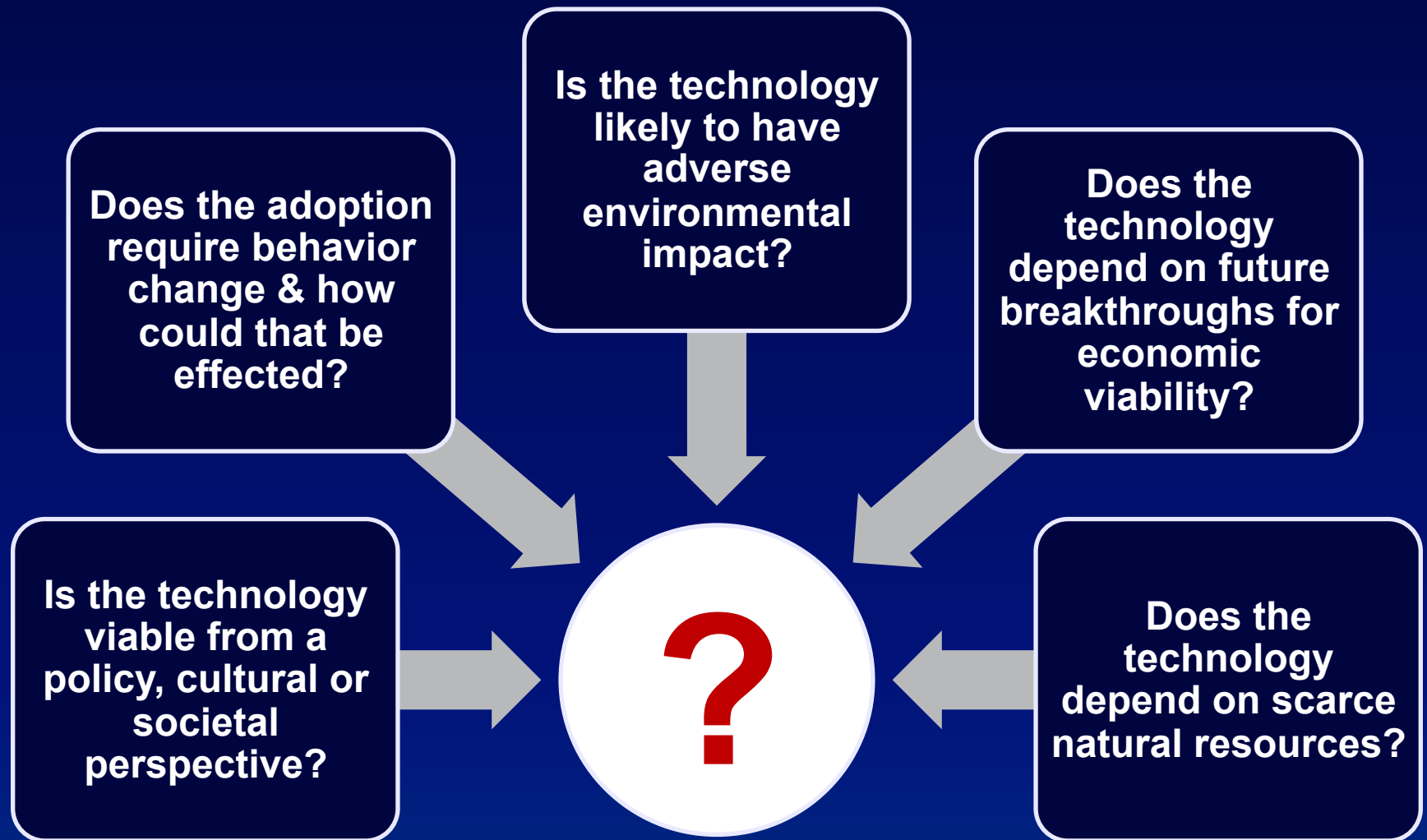
- As reflected in the research plan, expertise/roles of PIs, and the project management plan

Integration of education & workforce development in research

- As reflected in the potential effectiveness and impact in educating students and promoting public understanding of sustainable energy



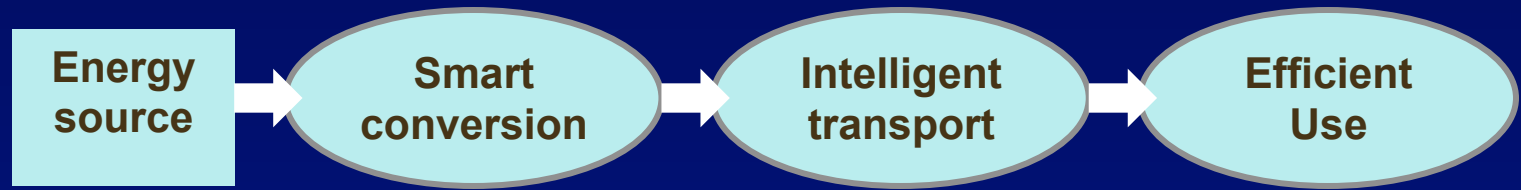
Key Considerations in SEP Vision



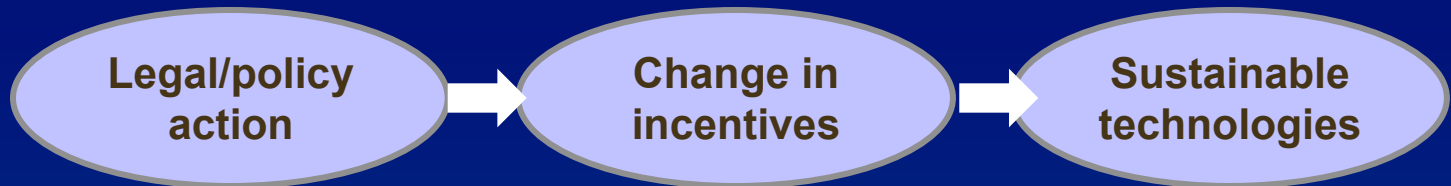
What is a Sustainable Energy Pathway?

A set of coordinated and well orchestrated steps to advance the goal of a sustainable energy future

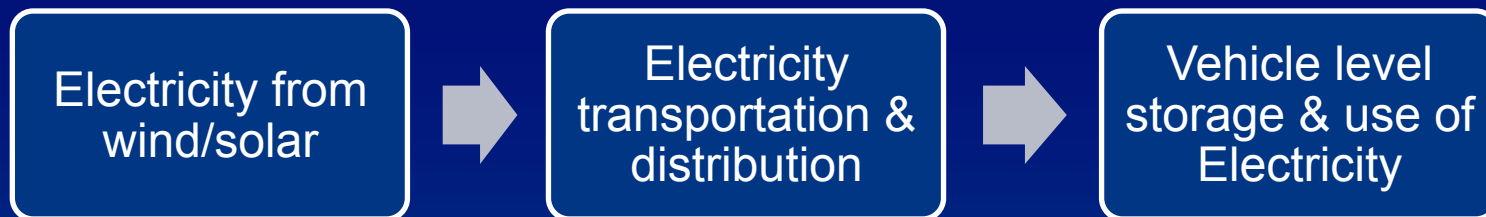
Example 1



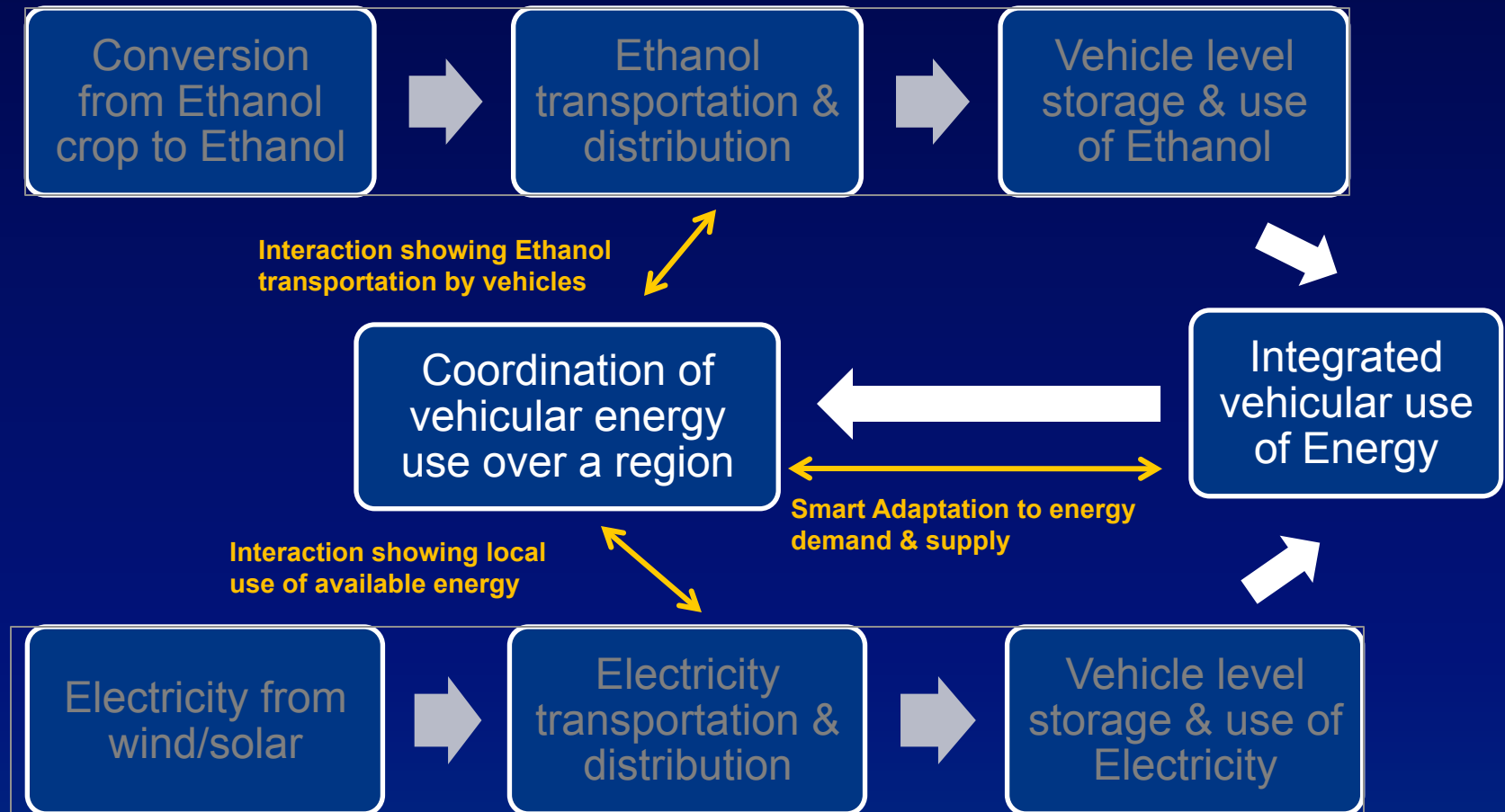
Example 2



Energy Sub-Pathway for Transportation



Building the Entire Pathway



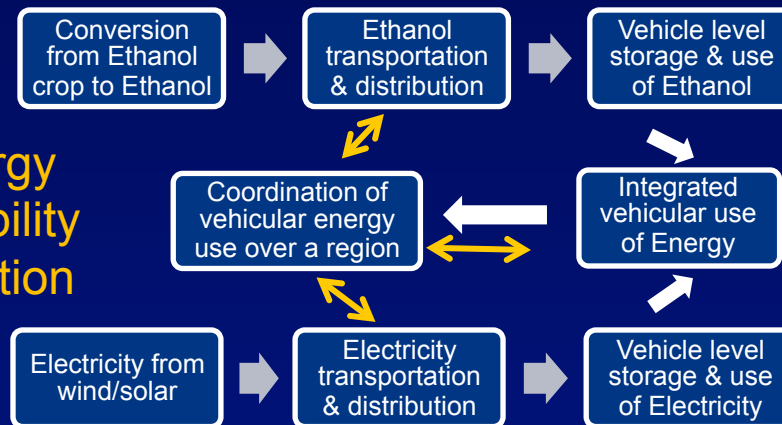
Some CISE Research Opportunities

Optimization of transmission & distribution systems for raw materials, fuels & energy

Smart local monitoring (inside & around vehicle) and energy management

New technologies for energy routing & storage mgmt

Conversion side energy management, availability prediction & optimization



Global monitoring (e.g., metro region wide), data collection & analytics

Integration, resilience, and survivability of energy networks

Site selection & capacity planning of “filling” stations

Global energy management (scheduling, platooning, ...), robustness and security



Research Coordination Networks

NSF 11-531

Amount

\$7.5M to \$17.5M (pending availability) for 15-25 awards

Awards

Up to \$750K total
Over 4 - 5 years

Requirements

No collaborative proposals; only subawards by lead institution

Restrictions

No participation limits

- Existing program with SEES track added for FY12
 - CISE supporting only the SEES track
- Supports collaboration between existing research efforts
 - Does not support research activities, only networking activities
 - Intended for creating new networks, not sustaining old ones
- Expected to include diverse organizations
 - International participation highly encouraged & expected to be of mutual benefit
 - Just involving multiple CS/CE participants is inadequate

Due Date: Feb 03, 2012



2011 RCN Awards

11 awards given in 2011, two of them co-sponsored by CISE

Sustainable Energy Systems

Arizona State U

Award: \$750,000

Sponsors: CISE, OISE+

A collaborative network of University Centers, industrial partners, and regulatory agencies.

Seeks to exploit multidisciplinary advances in nanotechnology related to energy generation (e.g., photovoltaics), storage (e.g., batteries), and transmission (e.g., integration of renewables in the electric grid).

Sustainable Cities: People and the Energy-Climate-Water Nexus

Univ of Colorado at Denver

Award: \$749,930

Sponsors: CISE, GEO, MPS+

A national network of researchers from 20+ US Universities and 2 National Labs. Collaborates with international sustainability research networks (in Australia, EU, Asia).

Research has an emphasis on reducing energy use and carbon emissions and mitigating climate-risks to water supply and public health in cities.



Two Past RCNs (2007)

GLEON

Global Lake Ecological Observatory Network

A network of limnologists, ecologists, IT experts, and engineers to build a scalable network of lake ecology observatories

FluxNet

A Global Network of Flux Tower Networks

An infrastructure to collect and distribute data using a global array of towers that measure CO₂ exchanges, water vapor, and energy between biosphere and atmosphere.

Sustainability Research Networks

NSF 11-574

Amount

\$36M for 3 - 4 awards

Awards

Up to \$2.4M/year for up to 5 years
Amount requested to be
consistent with project scope

Restrictions

Max 3 proposals per organization
Max 1 proposal per PI
No collaborative proposals; only
subawards by lead institution

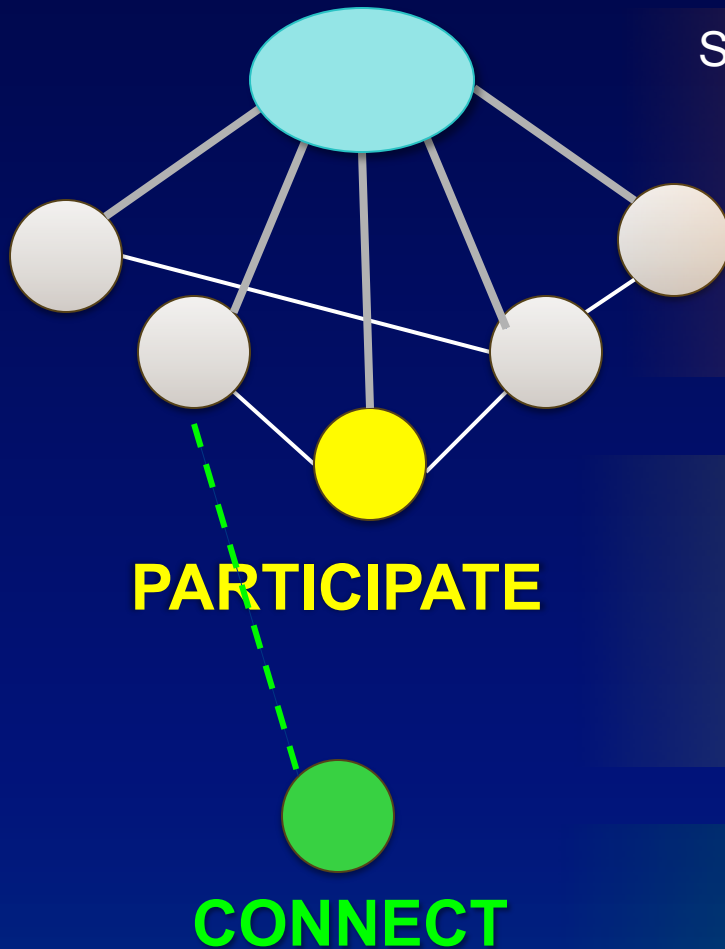
- Goes beyond RCN-SEES
 - Intended for much larger, nationally important sustainability themes
 - Can fund gaps or new essential research for a comprehensive thematic coverage.
 - Can enhance existing research networks
- Encouraged to develop linkages with other networks, government entities, and the private sector, both nationally and internationally
- Multidisciplinary education and training are crucial components

Preliminary Due December 1, 2011

Full Due April 1, 2012

Site Visit Summer 2012

CISE Opportunities in SRNs



SRNs involving coordination of complex IT-infused ecosystems, e.g., large scale e-health or smart transportation systems, Interactions between consumer segments of a resource

by contributing on CISE aspects of sustainability themes such as understanding, mitigation, and adaptation to global change, or responding to extreme events

in the future, and tap into a funded SRN via a RCN, PIRE, another SRN, or other project



SRN Review Criteria

Preliminary proposals

- Is the vision sufficiently compelling to justify the investment?
- Is there a framework to address social, economic, and environmental components?
- Is the goal of overcoming barriers to sustainable well-being addressed?
- Are the approaches proposed innovative and flexible?
- What are the contributions of partners and the management structure?
- Does the SRN leverage existing research/education nodes?
- Is there a plan to develop workforce for the tackling complex issues of sustainability?

Additional considerations for full proposals

- Quality of management plan and team
- Quality of educational activities and efforts to broaden participation
- Level of community participation and external engagement



Potential SRN Theme: Urban Sustainability

Situation

80% of US population lives in cities

Huge ongoing migration to cities in developing world

Complication

Megacities consume resources at prodigious rate

How do we develop sustainable urban systems?

Resolution

There are many opportunities for the CISE community to join in the search for solutions

(e.g., energy, food, water, health, transportation)



Potential SRN Theme: Energy Dynamics

Coordination of energy conversion, distribution, and consumption across multiple segments, e.g.,

- Distributed electricity generation from multiple sources and its two way flow
- Electricity consumption in homes, offices, factories, data centers, vehicles, etc.
- Fuel distribution & use in transportation systems, heating systems, etc.



NSF SEES Fellows

NSF 11-575

Amount

\$6 - 8M for 12 - 20 awards

Awards

2 - 3 years of fellowship costs
\$88K/year in salary, \$20K/year in research expenses, \$10K/year in international research costs

Requirements

Applicants must be US citizens, nationals, or permanent residents

Applicants must have received PhD within 4 years of deadline

Restrictions

One proposal/PI

To create the necessary workforce to enable discoveries leading to environmental, energy, and societal sustainability

- The Fellow's proposed research should:
 - Cross traditional disciplinary boundaries
 - Go beyond his/her current core disciplinary expertise
 - Address issues of sustainability through a systems approach
 - Build bridges between academic inquiry, economic growth, and societal needs
- Fellows must develop a research partnership in order to broaden the impact/scope of the proposed research
- Fellows are expected to devote time to a professional development activity

Due December 5, 2011

Due Thereafter First Monday in December



SEES Fellows review criteria

Full proposal (the prospective fellow is the PI)

- Intellectual merit & broader impact criteria
- Additional criteria: will the proposed project
 - SEES-related
 - Integrate across NSF-supported disciplines by creating new interdisciplinary networks/collaborations?
 - Advance the foundations of sustainability?
 - Research Host and Research Partner
 - Help the applicant expand beyond his or her current core disciplinary expertise?
 - Via the research partnership, broaden the impact and/or scope of the proposed research?
 - Via international partnerships, bring mutual benefit of expertise, facilities and/or resources?
 - Professional development
 - Enhance the applicant's professional growth while complementing the proposed research?



Partnerships for International Research and Education (PIRE)

NSF 11-564

Amount

\$10 - 15M (annually) for 10 - 15 awards

Awards

\$4M expected average award
Over 5 years

Requirements

Preliminary proposals required

Restrictions

1 proposal per institution (as lead)

Goals:

To facilitate development of a diverse, globally engaged US science and engineering workforce.

To promote opportunities where international collaboration can enable advances that could not occur otherwise.

To engage and share resources and infrastructure within and across institutions to build international partnerships.

- FY2012 solicitations focuses solely on SEES topics
- Encourages research on global sustainability including climate change, clean energy, food security, biodiversity, and communication networks.
- Proposals should address linkages across natural social and/or built environments

Preliminary Due October 19, 2011

Full Due May 15, 2012



Additional Opportunities for CISE

Coupled Natural Human Systems

- Quantitative, interdisciplinary analyses of human and natural system processes and complex interactions at diverse scales
- Support for exploratory awards & RCN

NSF 11-612

Amount

\$17 for 5 - 17 awards

Awards

\$150K to \$1.5M, depends on award type

Due November 15, 2011

Water Sustainability and Climate

- Modeling to predict impact of climate variability and change, land use, and human activity on water systems.
- Developing adaptive water resource management
- Designing water systems to be more resilient and sustainable to meet diverse and conflicting needs

NSF 11-551

Amount

\$31M for 12 - 26 awards

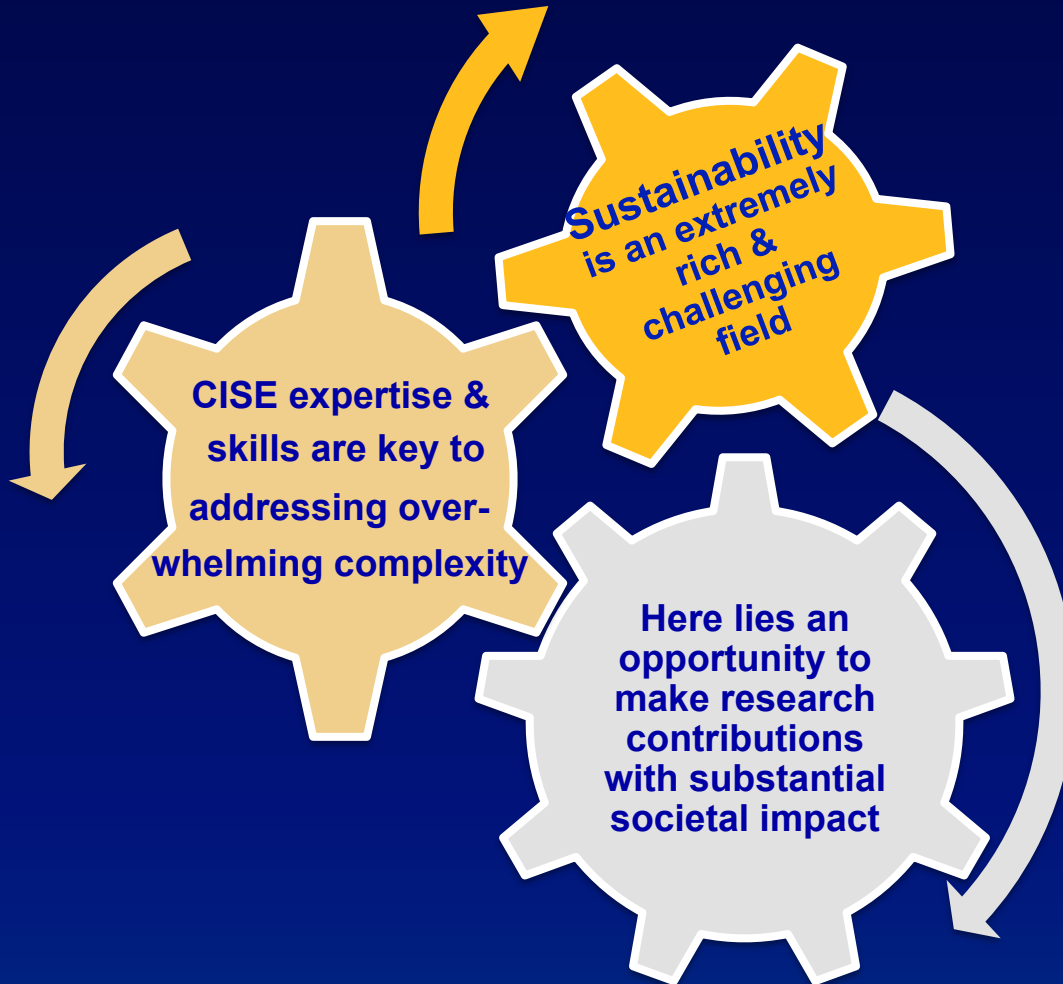
Awards

\$150K to \$1.5M, depends on award type

Due October 19, 2011



An Opportunity for CISE Community



The Time is Now

Sustainability problems
are not going away

Support for
sustainability research
continues to expand

**Please
Participate!**



Additional Resources

- SEES web links
 - Master site: www.nsf.gov/sees
 - Will have a link to this presentation
 - FAQs: <http://www.nsf.gov/pubs/2011/nsf11039/nsf11039.jsp?org=NSF>
 - DCL: <http://www.nsf.gov/pubs/2011/nsf11022/nsf11022.jsp?org=NSF>
- Questions
 - General queries on solicitations:
 - sep@nsf.gov, srn@nsf.gov, seesfellows@nsf.gov, PIRE-info@nsf.gov
 - SEES queries:
 - General: nsf-sees-info@nsf.gov
 - Discipline Specific: http://www.nsf.gov/geo/sees/sees_contacts.jsp





WHERE DISCOVERIES BEGIN

Questions?

Fellows: pdrineas@nsf.gov,
SEP, SRN, RCN: kkant@nsf.gov

